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DEFENSE SYSTEMS MANAGEMENT COLLEGE



PROGRAM MANAGEMENT COURSE INDIVIDUAL STUDY PROGRAM

IMPACT OF DODD 5000.29, "MANAGEMENT
OF COMPUTER RESOURCES IN MAJOR DEFENSE
SYSTEMS", ON THE NAVAL AIR SYSTEMS
COMMAND (NAVAIR)

STUDY PROJECT REPORT
PMC 76-2

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FORT BELVOIR, VIRGINIA 22060

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: Impact of DODD 5000.29, "Management of Computer Resources in Major Defense Systems", on the Naval Air Systems Command (NAVAIR)

STUDY PROJECT GOALS:

To determine the management approach tools to be utilized in the management of software design, engineering, and programming at NAVAIR, which will ensure the provision of effective software at minimum life cycle costs for computer resources embedded within weapon systems. To identify and define the appropriate implementing NAVAIR instructions and guidance documents which must be prepared.

STUDY REPORT ABSTRACT:

The purpose of this study was to assess the impact of DODD 5000.29 on the Naval Air Systems Command and to determine what steps and actions should be taken to implement the policy contained therein.

Existing service component instructions and guidance documents relating to the management of computer resources were examined for compliance with DODD 5000.29 and as a source of new ideas for use at NAVAIR in preparing new NAVAIR guidance documents. Applicable Military Standards and Specifications were reviewed as well as computer resources reports of studies performed by DOD and the Navy.

This report sets forth the history of DODD 5000.29, the present situation at NAVAIR, and an examination of existing Service Component Policy and guidance documents.

The author's conclusions and recommendations are set forth in the final section of this report. The recommendations include the updating of the existing computer resources related NAVAIR instructions and certain NAVAIR program management guidance documents. Recommendations for inclusion of additional material into a draft NAVAIR Software Management Manual is presented.

KEY WORDS: Computers and Management; Computer Software; Software Management

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IMPACT OF DODD 5000.29, "MANAGEMENT
OF COMPUTER RESOURCES IN MAJOR DEFENSE SYSTEMS",
ON THE NAVAL AIR SYSTEMS COMMAND (NAVAIR)

Study Project Report
Individual Study Program

Defense Systems Management College
Program Management Course
Class 76-2

by
Victor E. Skullman Jr.
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November 1976

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This study project report represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management College or the Department of Defense.

EXECUTIVE SUMMARY

The purpose of this study is to review the existing computer resources policy guidance within the Department of Defense and the Service Components in the light of the newly issued Department of Defense Directive 5000.29 and to determine the actions which should be instituted at the Naval Air Systems Command (NAVAIR) in order to fully effect the policy stated therein. The pertinent policy and guidance documents prior to October 1976 are discussed for each of the services. The current status of computer resources policy and guidance documents at NAVAIR is presented and discussed as to its application in light of policy set forth in DODD 5000.29.

The review of existing Service Component policy guidance is of importance for two reasons. First, it can be inferred from the present situation why DODD 5000.29 was promulgated. An obvious finding is the lack of uniformity across and within the Service Components with regard to the management of weapon systems computer resources and the rising costs associated thereto. Secondly, the review provides a source of new ideas for consideration in the updating of NAVAIR's existing guidance documents.

Specific recommendations are presented which if implemented at NAVAIR would promulgate the policy set forth in DODD 5000.29 for Navy airborne weapon systems computer resources.

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SECTION I

INTRODUCTION

Purpose

The purpose of this study is to assess the impact of Department of Defense Directive (DODD) 5000.29, "Management of Computer Resources in Major Defense Systems", on the Naval Air Systems Command (NAVAIR). DODD 5000.29 establishes policy for the management and control of computer resources during the development, acquisition, deployment and support of major Defense systems (12:1)¹. DODD 5000.29 was dated and became effective on 26 April 1976. As of the date of this report, no Secretary of the Navy Instruction (SECNAVINST), Naval Material Command Instruction (NAVMATINST), or Naval Air Systems Command Instruction (NAVAIRINST) had been promulgated which specifically implements DODD 5000.29.

Goals

The goals of this report are to determine what steps and actions should be taken at NAVAIR in order that timely compliance with DODD 5000.29 is achieved. The effect of achievement of these goals will result in reliable computer resources being acquired which meet the mission requirements for Navy airborne weapon systems at minimum life cycle costs.

¹ This notation will be used throughout the report for sources of quotation and major references. The first number is the source listed in the bibliography. The second number, if listed, is the page in the reference from which the quotation or reference was taken.

Definitions

The following definitions have been utilized in this report:

Computer Data. Basic elements of information used by computer equipment in responding to a computer program.

Computer Equipment. Devices capable of accepting and storing computer data, executing a systematic sequence of operations on computer data or producing control outputs. Such devices can perform substantial interpretation, computation, communication, control, and other logical functions.

Computer Program. A series of instructions or statements in a form acceptable to computer equipment, designed to cause the execution of an operation or series of operations. Computer programs include such items as operating systems, assemblers, compilers, interpreters, data management system, utility programs, and maintenance/diagnostic programs. They also include application programs such as payroll, inventory control, operational flight, strategic, tactical, automatic test, crew simulator, and engineering analysis programs. Computer programs may be either machine dependent or machine independent, and may be general purpose in nature or be designed to satisfy the requirements of a specialized process of a particular user.

Computer Resources. The totality of computer equipment, computer program, computer data, associated documentation, personnel, and supplies.

Computer Software. A combination of associated computer programs and computer data required to enable the computer equipment to perform computational or control functions.

Embedded. Adjective modifier; integral to, from the design, procurement, and operations point of view espoused in DOD Directive 5000.1.

Software Engineering. Science of design, development, implementation, test, evaluation, and maintenance of computer software over its life cycle.

Scope

This report will be limited to determining the management approach and management tools which should be utilized by NAVAIR in the management of computer resources for both major Defense systems, as set forth in DODD 5000.1, "Acquisition of Major Defense Systems", and less than major Defense systems (11). DODD 5000.29 sets forth the responsibilities of the Department of Defense (DOD) Components to (1) review their existing regulations, specifications, and standards with the purpose of modifying, cancelling, or supplementing them as required to ensure consistency with the policy of DODD 5000.29 and (2) develop and implement a disciplined approach to the management of software design, engineering, and programming which will ensure the provision of effective software at minimum life cycle cost (12:4).

Limitations

The report is limited to the responsibility set forth at the Naval Material Command (NMC) for the Tactical Digital Systems Office (TADSO), MAT-09Y, and at NAVAIR for the Director of the Avionics Division (AIR-533) and the Computer and Software Branch (AIR-5331) for the implementation of policy set forth in DODD 5000.29. DODD 5000.29 specifically excludes from its provisions the general purpose, commercially available automatic

data processing (ADP) assets which are administered under OMB Circular A-71, DODD 4105.55, 4160.19, and 5100.40 references (37), (9), (10), (11), and (13) respectively. DOD 5000.29 does state:

....where feasible, the terms, tools, and techniques employed in the general purpose area will be adopted or adapted to support management of computer resources in major Defense systems (12:1).

TADSO's responsibility does not include policy formulation and application aspects of strategic, automatic test, business and logistics systems; but does include interface between such systems and tactical systems (33:1). AIR-533 responsibility is limited to weapon system tactical digital processors and related software (28:2). The report therefore will not address in detail digital computer utilized in automatic test equipment (ATE) or trainers.

Organization of the Report

The report is organized such that a case is built for the conclusions and recommendations presented in Section VI. Section II discusses the collection of data and how it was used in arriving at the author's recommendations. Section III presents the history of DODD 5000.29 and discusses the studies and analysis leading up to its issuance. Examples are presented to show some of the problems which have and are being experienced in the development and acquisition of software. Section IV sets forth the existing policy and guidance documents being utilized at NAVAIR and discusses two new documents being prepared. Section V analyses and compares computer resources policy and guidance documents which exist for the service components. Military Standards (MIL-STDs) and Military Specifications (Mil-SPECs) that are applicable to software acquisition

are discussed. Section VI sets forth the author's conclusions and recommendation as to what new computer resources policy and guidance documents should be implemented at NAVAIR.

SECTION II

DATA COLLECTION AND ANALYSIS METHOD

The methodology used to perform this study is based on the author's knowledge of the tactical computer and software efforts at NAVAIR over the past five years and discussions with Navy tactical software personnel at NMC and NAVAIR. Applicable computer resources policy guidance documents for the Service Components were collected and analyzed as to compliance with DODD 5000.29 and as a source of ideas for use in preparing new guidance at NAVAIR. Recent software acquisition reports and studies were analyzed in the hopes of finding new methods and approaches for implementing better software management technique. Existing MIL-STDs relating to the management of computer resources are reviewed and discussed since some are approved and are mandatory for use by all Departments and Agencies of the Department of Defense and others are approved only for use by a given service component.

SECTION III

HISTORY OF DOD DIRECTIVE 5000.29

Background

The need for DODD 5000.29 is appropriately summarized in the Office of the Assistant Secretary of Defense, Installations and Logistic, cover letter for the DOD Defense System Software Management Program of March 1976 which states:

The sharply rising costs of software programs in the Defense system acquisition process, with respect to acquisition procedures, development and maintenance of such software, and the increasing importance of the software roles in the overall mission effectiveness of major Defense Systems constitute serious technical and management problems that must be solved if we are to have the Defense Systems that are needed for our national security (6:i).

These same words were essentially used in the 3 December 1974 memorandum issued by the Assistant Secretaries of Defense (Installations and Logistics and Comptroller) and the Director of Defense Research and Engineering which initiated a two phase study program into the area of management of weapon systems software (36:1).

The weapon systems of today are very complex and consist of many integrated subsystems many of which are controlled by digital computers and their associated computer software. The Department of Defense and the Service Components have many policies, regulations, procedures, Military Standards (MIL-STDs) and Military Specifications (Mil-SPECS) which deal with the acquisition and management of military hardware; however, very few of these are applicable to computer software. The results are that serious technical and management problems do indeed

exist as is evidenced by sharply rising life cycle costs of software programs.

The PMC 76-1 Study Project Report by Mr. Pontius is recommended as a source of information concerning life cycle guidelines for weapon system software management (38). Mr. Pontius provided a strategic level exposure to problems inherent in the management of computer software and highlighted key documents which have been promulgated and resulted in top management in both DOD and the Service Components becoming more aware of the lack of controls on and the rising costs of weapon system software.

The October 1975 issue of the Defense Management Journal was dedicated to DOD weapon system software articles (8). The "Comment" section by Mr. Gansler, Deputy Assistant Secretary of Defense (Material Acquisition), OSAD(I&L), inforces the growing awareness of the software problem and stated:

In recent months, managers in Defense and industry have been challenged by three important weapon systems issues: the lack of sufficient control over rapidly growing software expenditures, the lack of sufficient research and development in software production, and the need for major improvements in weapon systems software management (8:1).

An excellent paper which presents the history of digital computers in weapon systems was prepared by Mr. Zempolich while a student at the Industrial College of the Armed Forces and provides an analysis of computer software management for operationally deployable systems (48). The research for the paper was performed in the June 1973 to February 1974 time frame. The paper is recommended as a source of information and references for the reader desiring additional depth into the software management problem from a historical point of view. As a note of interest,

Mr. Zempolich was the original section head at NAVAIR for the group of people destined to become the Computer and Software Branch (AIR-5331).

DOD Directive 5000.29

DOD Directive 5000.29 sets forth the DOD policy for the management and control of computer resources during the development and support of major Defense systems (12). The policies set forth cover the areas of:

1. General management policy
2. Validation and Risk Analysis
3. Configuration Management
4. Life Cycle Planning
5. Support Software Deliverable
6. Milestone Definition and Attainment Criteria
7. Software Language Standardization and Control

The directive established a Management Steering Committee for Embedded Computer Resources to oversee and coordinate the incorporation of its policies and principles into the normal Defense systems acquisition process. The directive further required the Service Components to review and modify or supplement existing regulations and procedures to ensure consistency with the policy set forth.

The Defense System Software Management Plan of March 1976 sets forth the DOD Software Management Steering Committee's detailed plan for the solution of DOD computer resources management problems (6). The plan sets forth the actions and responsibilities of the organizations involved in implementing the requirement of DODD 5000.29.

DOD Studies and Reports

The Office of the Secretary of Defense Memorandum of 3 December 1974 established the DOD Software Steering Committee to oversee a coordinated and joint study by the Applied Physics Laboratory (APL) at John Hopkins

University and the Mitre Corporation (36). Each was to conduct separate but coordinated, four month studies to identify and define:

- (1) the nature of the critical software problems facing the DOD,
- (2) the principal factors contributing to the problems,
- (3) the high pay-off areas and alternatives available, and
- (4) the management instruments and policies that are need to define and bound the functions, responsibilities and mission areas of weapon systems software management (36:1).

The second phase of the study was an indepth study into the critical areas identified in the four month study period. The results of these studies and the recommendations of the DOD Software Steering Committee resulted in the promulgation of DODD 5000.29.

The APL study set forth, under seven categories, specific actions which should be taken to attack many of the problems encountered in the software development and support area. The seven categories were (1) Management Policy, (2) Acquisition Planning, (3) System Engineer, (4) Implementation Procedures, (5) Program Management Support, (6) Acquisition Management Standards, and (7) Development Task and Techniques (15:2-1). Table 6-1 presented on page 6-3 of the report provides a matrix showing direct and indirect correlations between the recommendations set forth under the seven categories listed above and the problem area in each of the five phases of the acquisition life cycle as seen by APL. Figure 1-1 on page 1-3 of the report sets forth the same problems in the form of a life cycle flow diagram.

The Mitre study set forth four high payoff areas which should be addressed by DOD. The four areas were (1) software performance specification, (2) software acquisition planning, (3) software technology, and (4) personnel (14:xiii). Mitre recommended the review of software

earlier in the Defense Systems Acquisition Review Council (DSARC) process, the consistent application of sound engineering principles, the need for complete software specifications, the establishment of a coordinated software technology program, and the need for a consistent framework and definition of recommended software management practices.

The reports of both studies are recommended for indepth study since prior software studies are reviewed and summarized. The bibliography to the APL study contains three hundred fifty seven references.

Mr. DeRoze, Directorate for Weapons Support Systems Acquisition, OSD(I&L), summarized the results of the APL and MITRE studies in his article "An Introspective Analysis of DOD Weapon System Software Management". Mr. DeRoze's article set forth the areas which were to become DOD 5000.29 policy. Mr. DeRoze summarized the problem areas as follows:

- (1) Visibility in weapon system acquisition
 - * Inadequate requirements analysis
 - * Inadequate interface management
 - * Inadequate documentation
 - * Lack of transferability
 - * Inaccurate cost/schedule projections
 - * Low quality
- (2) Language selection
 - * Low correlation of machine-oriented language to engineering problems
 - * Lack of design visibility
 - * Machine dependance
- (3) Language proliferation
 - * Difficult learning process
 - * Discourages development of test and support equipment
 - * Reduces management visibility
 - * Complicates institutional control
 - * Cost reduction
- (4) Quality assurance and control
 - * Lack of management monitoring of software reliability
 - * Lack of software reliability quality assurance disciplines
 - * Lack of quantitative data base

- (5) Lack of software acquisition management standards
 - * Terminology
 - * Directives, instructions, standards
- (6) Lack of acquisition, management, operations and support guideline
- (7) Lack of formal personnel development and training
- (8) Research and development
 - * Lack of focus
 - * Relevancy
 - * Lack of technology base
 - * Redundancy and duplication (8:6)

A major study which has influenced DOD is the "Findings and Recommendations of the Joint Logistics Commanders Software Reliability Work Group (SRWG Report) of November 1975. The report documents over a year's work by 30 computer software professionals from DOD, industry, and the academic community. Of particular interest is the follow statement from the report:

Soon after initiating their investigation into the software reliability question, the Software Reliability Work Group (SRWG) found it necessary to address the much broader area of computer resource acquisition for military systems (17:i).

The detailed finding and recommendations of the SRWG are set forth under the following recommendations categories: (1) change in policy and procedure, (2) software reliability improvement, (3) management procedures, (4) changes in technical training and technology improvement, (5) establishment of a new capability, (6) reliability improvement program, and (7) changes in policies at the OSD level, procedures at the DOD and component service levels and a reliability improvement program are necessary. The SRWG findings and recommended solutions are embodied in DODD 5000.29.

Navy Studies and Reports

The MUDD Report written by Mr. Weiss of the Naval Research Laboratory (NRL) in May 1975 presents milestones in the development of a fictional

software development program of a Navy weapons system. The fictional narrative prepared by Mr. Weiss is well worth reading since, in a humorist way, he presented real world software development and acquisition problems which have been encountered in the Navy. Of particular importance are the recommendations he presented:

- * Unify life-cycle control of software.
- * Require the participation of experience software engineers in all system decisions.
- * Require the participation of system users in the development cycle from the time requirements are established until the time the system is delivered.
- * Write acceptance criteria into software development contracts.
- * Develop software on a system that provides good support facilities.
- * Design software for maximum compatibility and reusability.
- * Allocate development time properly among design, coding, and checkout.
- * List, in advance of design, all areas in which requirements are likely to change
- * Use state-of-the-art principles, such as information hiding.
- * Critical design reviews should be active reviews and not passive tutorials.
- * Do not depend on progress reports to know the state of the system.
- * Require executable milestones that can be satisfactorily demonstrated.
- * Ensure that a proper variety of test data is used.
- * Maintain current, complete documentation (46:25 thru 28).

The recommendation of Mr. Weiss are typical of the areas which should be expanded and incorporated into appropriate service guidance documents as required by paragraph VI, C, 1 of DODD 5000.29 (12:4).

In the 25 June 1974 Memorandum of Mr. Potter, Assistant Secretary of the Navy (R&D), he stated that:

There currently is no formal or structured program for software research and development within the Navy. An endeavor that holds promise in increasing the efforts of software research and development in the recently formal Department of Defense Software Committee. The Navy has recently formed a Laboratory Computer Committee, comprised of representatives from the Navy's research and development activities, which will aid the efforts of the Department of Defense Software Committee (7:1).

The Navy Laboratory Computing Committee has produced two reports, the Operational Software Panel Report dated September 1975 (39) and the Software Technology R&D Panel Report dated September 1976 (40). The Operational Software Panel presented Navy software problems and provided recommendations for their solution. Twenty-three (23) problem areas were set forth. Some of the more critical problem areas include:

- * Software inadequately addressed in the definition of system development requirements
- * Nonstandardization of hardware and software
- * Incomplete software life cycle planning
- * Nonuniform management practice (Navy and developer/contractor)
- * Poor performance monitoring by management
- * Poor utilization of corporate memory
- * Inadequate contract specification for software
- * Inadequate testing
- * Poor quality assurance
- * Inadequate documentation
- * Insufficient personnel training
- * Underestimation of support cost with consequent need for supplementary funding
- * Lack of feedback (developer - user interaction) (39:13, 14, 15)

The panel's recommendations stressed (1) the need for management procedures that address cost-effective and timely preparation for operational support of system software, (2) the need for a Navy Laboratory or other in-house activity to be actively involved in major Navy software efforts, and (3) the need for software technology R&D efforts on a board front in areas such as software reusability, design, error classification, standards, and specifications.

The software Technology R&D Panel similarly discussed Navy software problem areas and concluded that there was a common set of software problems in the areas of command-control, weapon systems, logistics, and general scientific including computer-aided design (40:3). The panel recommended a five year 52.6 million dollar program to be centrally

managed by Chief of Naval Technology (MAT-03T) in the area of research initiatives and the exploitation of developing research results for software technology (40:4.5).

A draft NMC R&D Program for the Management of Computer Resources in Navy Systems, dated 7 September 1976, has been prepared by the Naval Sea Systems Command (34). The draft plan expands an original draft prepared and forwarded on 20 August 1976 by MAT-03Y to the Navy System Commands. The plan sets forth a proposed NAVMAT Computer Sciences R&D Council to assist the Chief of Naval Material (CNM) in managing a coordinated 6.1 thru 6.4 R&D funds expenditure to development and transition software system design and development methodologies into tools and technologies which will aid managers, designers, developers, and maintainers in solving existing computer resource problems. The time frame for the efforts are from FY 78-82 with individual efforts running from one to five years depending on the particular task area.

Industry Studies and Reports

An active group on the industry side of the computer resources problem in DOD is the Electronic Industries Association, G-33 Data and Configuration Management, Committee's Computer Software Task Group (16). The Electronic Industries Association is composed of members of industry who are DOD contractors and are therefore extremely interested in DOD and Service Components regulations, policy, MIL-STD's, and MIL-SPEC's. The minutes of the 27 July 1976 session of the Computer Software Task Group reflect that the group has finalized a mark-up of DODD 5000.29 for forwarding to DOD. The minutes show that the group discussed in detail the re-write of the

appendices relating to B5 and C5 Computer Software Specifications in
MIL-STD-490 (22).

SECTION IV

REVIEW OF PRESENT SITUATION AT NAVAIR

General Description

The Director of the Avionics Division (AIR-533) is responsible for the management of all weapon system tactical digital processors and related software at NAVAIR. The Computer and Software Branch (AIR-5331) attends to the day-to-day operations and interface with the NAVAIR program managers. The personnel in AIR-5331 are electronic engineers and computer specialists with indepth knowledge and experience in real time tactical digital computer systems. To date the success of the branch has greatly depended on the informal organization and strength of the people in the branch. True policy guidance in the form of NAVMATINSTs or NAVAIRINSTs is lacking at NAVAIR; however, certain new documents are being prepared.

Timely management of NAVAIR's embedded computer resources has been a prime concern of the Computer and Software Branch since its formation in the summer of 1974 by the Direction of the Avionics Division. Prior to 1974 the people who now compose the Computer and Software Branch were a section within the Radar Branch of the same division. The organization required to effect timely management of computer resources therefore really did not exist prior to 1974. With the promulgation of DODD 5000.29, the necessary top level DOD interest has been set forth and the mission of people at the functional levels with NAVAIR in accomplishing timely management of computer resources has been greatly strengthened.

In order to assess the current situation at NAVAIR, the applicable computer resources related NAVAIR instructions and guidance documents

will be presented and analyzed.

AR-59B

The NAVAIR Aeronautical Requirement, AR-59B, "General Management Requirements for Project Management", dated 1 May 1972, sets forth a PROMPT Guide. PROMPT stands for project reporting, organization, and management planning techniques and constitutes an inventory of management requirement which may be applied to a project. The NAVAIR Project Managers can use the PROMPT Guide as a shopping list from which they can select those requirements most closely statisfying their project's management needs. The PROMPT Guide is applicable to all major programs as set forth in DOD Directive 5000.1 and may be used in establishing management requirements for programs or projects of lesser magnitude.

Several observations can be made concerning AR-59. It was issued in May 1972 and is in need of being updated. It does not adequately set forth the acquisition management guidance which the NAVAIR Program Manager should consider in managing a major weapon system. The only guidance given the Program Manager in the software area is a sample definition under the Work Breakdown Structure paragraph (5:10).

MIL-D-8706B(AS)

This NAVAIR military specification sets forth the engineering data and tests requirement which may be invoked on a NAVAIR contract for aircraft weapon systems. The specification covers airframe requirement and Contractor Furnished Equipment (CFE). The required data is set forth on a DD Form 1423 which is part of the airframe contract. The only reference made to computer program data is that for a report outlining

the planned program for use of digital and analog computers used in analytically simulating the airplane response characteristics (18:4).

Several observations can be made concerning MIL-D-8706B(AS). The specification was last updated on 15 August 1968 and does not include appropriate software data requirements. The data requirements should not be specified in a military specification; but should be set forth in standard Data Item Descriptions (DIDs) since this is the DOD approach which should follow when acquiring data under a contract.

NAVAIRINST 5230.3A

This NAVAIR instruction requires that, as of March 1975, software documentation standards set forth in SECNAVINST 3560.1 be required in all contracts requiring the delivery of digital processor programs. Prior to March 1975, Weapon Specification WS-8506 was utilized as the software documentation standard. SECNAVINST 3560.1 and WS-8506 are discussed in Section V of this report.

In the background paragraph of NAVAIRINST 5230.3A, it is stated:

Documentation of digital processor programs has frequently been inadequately specified in contracts, thereby adversely affecting the quality of the program delivered. The lack of adequate documentation results in digital processor programs which are poorly designed, improperly implemented, inadequately tested, and inordinately difficult to manage (27:1).

The statement is appropriate since the software documentation standards which are invoked includes specifications, test plans and procedures, and manuals required for operating and maintaining the software program being procured.

NAVAIRINST 5230.4

This NAVAIR instruction was promulgated on 1 August 1974 and assigns responsibility for the management of all weapon system tactical digital processors and related software to the Director of the Avionics Division (AIR-533) (28:2). The instruction requires that cognizant program managers budget for and provide to AIR-533 sufficient funding to enable him to properly manage the weapon system computer resources. AIR-533's responsibility includes planning and implementing program for the design, development, test, evaluation, production engineering, standardization and basic design engineering support for tactical digital processor and related software.

The Division of the Avionics Division established the Computer and Software Branch (AIR-5331) to carry out the management responsibility.

NAVAIRINST 5230.5

This NAVAIR instruction sets forth the responsibility and requirements for preparation of Software Life Cycle Management Plans (SLCMP). The SLCMP for a major NAVAIR weapon system more than adequately satisfies the DODD 5000.29 policy requirement of paragraph V.D., for a computer resource plan. The SLCMP requires that the complete life cycle be addressed for the operational software of the weapon system and that the plan be originated prior to the Request for Proposal (RFP) for full scale development and shall be kept current thereafter throughout the life cycle of the weapon system (29:1). Enclosure (1) to the NAVAIR instruction sets forth in thirty five pages the format and content requirement for a SLCMP.

NAVAIRINST 5420.24

This NAVAIR instruction established the Naval Air Software Management Advisory Committee (NASMAC) on 30 January 1975 to address the establishment of software standards, specifications, management manuals and instructions (39). NASMAC is chaired by a NAVAIR representative and utilizes two software experts from each of six Navy field activities which are the Naval Air Development Center, Naval Avionics Facility Indianapolis, Naval Air Test Center, Naval Missile Center, Naval Surface Weapons Center Dahlgren, and Naval Weapons Center. These activities are currently assisting NAVAIR in developing and/or supporting NAVAIR weapon system software. This committee participated in the writing of NAVAIR instruction 5230.5 and the draft NAVAIRINSTs discussed in the following subsection.

Draft NAVAIRINSTs

The Computer and Software Branch (AIR-5331) is preparing two new software related NAVAIR instructions. One instruction will establish Software Change Review Boards (SCRB). The purpose of a weapon system SCRB is to consolidate all software changes which will be issued in the next fleet issue tape and prepare a Software Engineering Change Proposal (SECP) for processing through the NAVAIR Configuration Change Board (CCB). The Program Manager established the SCRB Chairman. The members of the SCRB will include members from the acquisition, logistic, test and evaluation committees, Navy field activities, fleet major command software representative and operation test and evaluation force representatives. The SCRB serves as a management discipline to exercise configuration control over weapon system tactical digital processor software and related

support software (38:1). The SCRB in conjunction with the existing NAVAIR CCB will satisfy the policy requirement of paragraph V,C. of DODD 5000.29 for configuration management of computer resources (12:2).

The second instruction that is being prepared is the NAVAIR Software Management Manual (26). The manual will set forth guidance similiar to that found in AFR 800-14, Volume I, and will be organized to follow the elements set forth in the newly promulgated NAVAIR SLCMP instruction (29).

SECTION V

ANALYSIS OF EXISTING SOFTWARE POLICY AND GUIDANCE DOCUMENTS WITHIN AIR FORCE, ARMY, AND NAVY

Air Force

The Air Force has several regulations, pamphlets, manuals, and military standards which address Acquisition Management. The Air Force Systems Command Pamphlet 800-3, "A Guide For Program Management", is similar to NAVAIR's AR-59B. Two differences, however, stand out. AFSC Pamphlet 800-3 was promulgated on 9 April 1976 and adequately sets forth the acquisitions phases as currently conducted and provides valuable guidance to an Air Force program manager where as AR-59B promulgated on 1 May 1972 does not provide the necessary up-to-date guidance the NAVAIR program manager needs. Secondly, AFSC Pamphlet 800-3 gives the program manager guidance for computer resources where AR-59B does not. As part of the validation phase, AFSC Pamphlet 800-3 states that (1) computer program specifications should be included as contract requirements (3:3-7) and (2) that the program manager should consider the AFR 800-14 computer resources requirements in planning the full scale development contract work statement tasks (3:3-8).

The Air Force AFR 800-14, Volume I, "Management of Computer Resources in Systems", dated 12 September 1975, establishes policy for the acquisition and support of embedded digital computers and computer programs. Its objective is to insure that computer resources in systems are planned, developed, acquired, employed, and supported to effectively, efficiently,

and economically accomplish Air Force assigned missions (1:1). The regulation sets forth ten (10) areas which must be provided for in the Program Management Plans (PMPs) and directs the program managers to provide management and technical emphasis to them. Some of the more important areas addressed are establishing technical and managerial expertise for computer resources preferably in the program office, providing sufficient computer equipment capacity and flexible computer program design during the planning and development phases to provide growth and ease of modification and maintenance throughout the system life, providing for the timely preparation of support plans, establishing comprehensive tests of computer equipment and verification and validation of computer programs, treating the computer equipment and computer programs as configuration items, utilizing work breakdown structures to facilitate identification of computer resource costs, and covering computer equipment and computer programs during the conduct of system design reviews, audits, and management assessments (1:2). The DODD 5000.29 policy closely aligns with the above. To date NAVAIR has not received the above type of policy guidance from the NMC nor does NAVAIR have similar policy guidance in the form of NAVAIR instructions.

The Air Force AFR 800-14, Volume II, "Acquisition and Support Procedures for Computer Resources in System", dated 26 September 1976, consolidates procedures that apply when implementing the policies of AFR 800-14, Volume I and other related Air Force publications as they pertain to the acquisition and support of computer resources (2:1). The regulation does an excellent job of relating the computer resources acquisition process to the existing Air Force structure originally designed for acquisition of hardware. Detail procedures are set forth such that

they can be tailored to the individual needs of a given program. Chapters are set forth which address areas such as planning, engineering management, testing, configuration management, documentation, contractual requirements, turnover and transfer, and support. To date NAVAIR has nothing like this; however a NAVAIR Software Management Manual is in preparation and will address similiar areas.

The Air Force has several service perculiar military standards which do set forth requirements for computer resources and are approved for use by the Department of the Air Force. MIL-STD-483 (USAF) sets forth configuration practices for computer programs (21). The standard expands upon the B5 and CS type software specifications set forth in MIL-STD-490 (22) and provides for Part I and Part II specifications. Ironically, these specifications are very similiar to what the Navy's SECNAVINST 3560.1 sets forth as Program Performance Specifications and Program Design Specifications (41). It is no wonder the DOD contractors are complaining about how the services procure software. All three documents (MIL-STD-483, MIL-STD-490, and SECNAVINST 3560.1) essentially provide for the same types of specifications in slightly different formats. MIL-STD-483 (USAF) expands upon MIL-STD-480 and provide Air Force perculiar forms and procedures for configuration control of computer program configuration items whereas MIL-STD-480 really doesn't adequately address this problem (20). MIL-STD-499A (USAF) sets forth the practices for engineering management (23). It ties together MIL-STD-483 (USAF) and MIL-STD-1521 (USAF) and provides a framework for the management of the engineering and technical effort necessary to transform a military requirement into an operational system. MIL-STD-1521 (USAF) sets forth the requirements for

conduction of technical reviews and audits (24). It provides for computer resources and details the areas which should be examined during the reviews and audits. It was published on 1 September 1972 and adequately addresses computer resources for that time period. In light of DODD 5000.29, it should be updated. The Navy is attempting to consolidate the above Air Force military standards into its draft MIL-STD-1697. This will be discussed later in the report.

In summary the Air Force does have the management of computer resources fairly well covered and comes closest of any of the services to meeting DODD 5000.29.

Army

The Army AMC Pamphlet 70-4, "Research and Development, Software Acquisition, a Guide for the Material Developer", dated September 1974, sets forth a guide book which is designed to instruct Army Material Command, now DARCOM (Development and Readiness Command), acquirers in the procurement of computer resources (4). It sets forth the traditional pitfalls in software acquisition, points out relevant guidance documentation, and offers alternatives and tradeoffs which may be adapted to the individual program. An interesting point brought out is that the Army personnel involved in software procurement should be aware of the numerous regulations and exhibits that have been published by the Air Force and the Navy over the past ten years which cover the acquisition of software systems. AMC Pamphlet 70-4 presents many of the Air Force military standards and provides guidance similar to the Air Force. It does provide a model statement of work which can be tailored for a given

software contract. Appendix C to AMC Pamphlet 70-4 provides in full many of the standard Data Item Descriptions, DD Form 1664, that have been prepared by the Air Force for use in contracts requiring the delivery of software data.

Navy

On 11 August 1971 the Chief of Naval Material established, by NAVMATINST 5230.5, the Tactical Digital Systems Office (TADSO), MAT-09Y, to be responsible for ensuring standardization, configuration and interface management, and compatibility of tactical automated data systems, equipment, and software (33:1). TADSO is responsible for formulating overall Naval Material Command (NMC) policy for tactical weapon system computer resources which is then implemented by the Navy Systems Commands (NAVAIR, NAVELEX, and NAVSEA). TADSO does not exercise direct control of funds but does possess approval/disapproval authority of the System Commands/program managers use of funds for computer resources and does participate in NMC budgeting, programming, reprogramming and other computer resources related program budget actions.

TADSO issues TADSTANDs (Tactical Digital Standards) in lieu of NAVMATINSTs to promulgate NMC policy in most instances. This is somewhat confusing since some are applicable to ships and aircrafts and others are only applicable to one or the other. NAVAIR has been attempting to get TADSO to do away with TADSTANDs and consolidate the policy in NAVMATINSTs. With the effort forthcoming to implement DODD 5000.29 hopefully this will be done. There are three TADSTANDs in particular which contain requirements that impact NAVAIR. TADSTAND 2, Revision 1,

sets forth the requirement for the standard specification of tactical digital computer program documentation in accordance with SECNAVINST 3560.1 (42). TADSTAND 4 sets forth standard definitions of tactical digital systems (43). TADSTAND 5 sets forth the standard reserve capacity requirements for digital combat system processors which is at least 20% reserve for installed memory, processor time, and input/output channels during the development phase (44).

TADSO has promulgated two additional documents for use by the Navy System Commands. One is the Navy and Marine Corps Tactical Digital Equipment Catalogue which contains a list of the current Navy inventory of digital processors, peripheral devices, and displays (35). The catalogue gives certain characteristics of the equipment and is to be used by the program manager to determine what computer equipment is available for use in his system without having to develop his own. The second document which has been issued is the U.S. Navy Tactical Digital Systems Tactical Data Systems Glossary and is to be used in the preparation of computer program documentation (45).

TADSO is in the process of having a Software Management Manual prepared but this was not available to the author for review. It will apparently attempt to implement for the Navy what AFSC Pamphlet 800-14, Volumes I and II, did for the Air Force. TADSO has also prepared a draft Navy military standard, MIL-STD-1697, which will be the Navy Tactical Software Development standard (25). It will provide requirements similar to that provided in MIL-STD-483 (USAF), MIL-499A (USAF), and MIL-STD-1521 (USAF). All the computer program documentation standards now contained in SECNAVINST 3560.1 will be rewritten in the form of

standard Data Item Descriptions, DD Form 1664, and will become an appendix to the new military standard. This will more closely align the Navy with the required DOD data procurement policy. The military standard when finalized will certainly aid the Navy in the management of computer resources.

NAVMATINST 5200.27A, prepared by TADSO, sets forth the procedures for transfer of Navy tactical digital system software responsibility from the developing activity to the program mainline activity (32:1). The instruction, dated 18 April 1973, required that the planning be included in the Integrated Logistics Support Plan (ILSP) or if no ILSP existed, a Software Life Cycle Management Plan (SLCMP) was to be generated. The plan is to include the major milestones required to achieve an orderly transfer, the resources required (funds, equipment, and people), documentation requests, and life cycle funding projection. This instruction basically satisfies the policy requirements of paragraph V.D. of DODD 5000.29 for computer resources life cycle planning. It should, however, be updated to include the requirement for the computer resource plan prior to DSARC II.

SECNAVINST 3560.1 sets forth the Department of the Navy Tactical Digital Systems Documentation Standards and provides a format to which computer program documentation is to be prepared (41). It includes specifications for the system, functional, interface, and program levels of a software system. It specifies test plans, test specifications, and test reports as well as operator's manuals. It provides for the program package itself which is the machine and human readable forms of the actual computer program. Prior to the issuance of SECNAVINST 3560.1 in August

of 1974, Weapon Specification WS-8506 (NAVORD), Revision 1, set forth the requirement for digital computer program documentation (47). WS-8506 is a subset of SECNAVINST 3560.1 and for small system provided adequate documentation.

The Navy then has had good standards to which computer program documentation was procured. What the Navy lacked was a policy guidance mechanism to implement what the people at the working level were attempting to do. The issuance of DODD 5000.29 should help solve this problem. TADSO does have members on the DOD Software Steering Committee and were active in the support of the issuance of DODD 5000.29.

Tri-Service Documents

One of the main reasons for the promulgation of DODD 5000.29 is the lack of standardization among the services in the area of management of computer resources. MIL-STD-490 sets forth the format for military specification and its B5 and C5 type formats are for computer program specification (22). How then did the Air Force arrive at its Part I and Part II computer program specifications found in MIL-STD-483 (USAF) and the Navy arrive at its computer program specifications found in SECNAVINST 3560.1 (41)?

The answer lies in the interruption of MIL-S-83490 (19). MIL-S-83490, Specifications, Types and Forms, is mandatory for use by all Departments and Agencies of the DOD and prescribes general requirements for the preparation of specifications. It essentially sets forth the Type A, B, C, D, and E specifications as described in MIL-STD-490, "Specification Practices". It does enable the procuring activity to specify the form of the

specification; that is Form 1a, 1b, or 2. Form 1a specification conforms to MIL-STD-490 in all details, Form 1b conforms to MIL-STD-490 except that not all element of a MIL-STD-490 specification need apply, and Form 2 is a specification to commercial practices with supplemented military requirements. This capability to select the form of a specification thus allowed the Air Force and the Navy to establish similar but different computer program specification requirement.

If a contractor does work for more than one service, he will have similar but different procedures for the generation of software data which results in unnecessary costs. If DODD 5000.29 can force the services to standardize their requirements, the DOD contractors will be in a position to more easily and cheaply provide the software data which DOD procures.

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The complexity of today's aircraft weapon systems has driven the Air Force and NAVAIR to the point of being highly dependent on digital computers. NAVSEA is in the same position with ship board systems being forced to put many highly sophisticated weapon systems aboard ships wide limited space. Fortunately NAVSEA has for the most part standardized its computer hardware and support software. All services have similiar problems in the procurement of computer programs. The Air Force has a better system for configuration management of computer programs. The Navy has a more indepth documentation requirement for computer program deliverables.

The analysis of the current status of computer resources related guidance documents within the Service Components revealed that the Air Force has in existance two documents which closely approach compliance with DODD 5000.29. AFSC Pamphlet 800-3 and AFR 800-14 set forth policy and guidance to Air Force program managers for the management of computer resources and the tailoring of existing Air Force documents and military standards. The Navy has no existing documents which adequately provide the same type of policy and guidance for its program managers. The program manager's PROMPT Guide at NAVAIR was issued in May 1972 and is in need of being updated. The Army appears to rely on Air Force military standards and tailor them as required.

DODD 5000.29, if implemented properly, should help solve the problem. The two most serious computer resources problems, which hopefully it will solve, are the lack of trained personnel and the lack of a tri-service effort in attacking the problem. From a review of the DOD Defense System Software Management Plan, the author estimates that it will take from 3 to 5 years to resolve the management problems and 5 to 10 years to establish and benefit from the proposed R&D technology effort. With the rate at which technology is doubling in the country, the author questions whether or not the saying, "the faster I go the further behind I get", is in fact not true?

What then should NAVAIR do in light of the current situation?

Recommendations

Several alternatives are available to NAVAIR. NAVAIR could standby and wait for implementing instructions from NMC and live within its existing NAVAIR documents for the time being. NAVAIR could decide to depend more heavily on its prime contractors and give them only broad requirements to satisfy DODD 5000.29. Neither of these alternatives provide a satisfactory solution to the rising cost associated with today's highly digitized weapon systems. The author's recommended solution is a two front attack on the problem.

The first problem to be solved is that of educating NAVAIR program managers and providing them with current acquisition guidance similar to that provided in AFSC Pamphlet 800-3 and AFR 800-14. NAVAIR's AR-59B should be updated and promulgated in the form of a NAVAIR instruction. The NAVAIR program managers should have available to them personnel,

either from the functional group at NAVAIR or a Navy field activity, who can realistically support them in the management of computer resources and the execution of related contracts.

The second problem is to complete the preparation of the two inprocess computer resources related NAVAIR instructions. The newly promulgated SLCMP instruction provides the framework in which the NAVAIR program manager may plan for and identify the critical computer resources required to adequately support his weapon system throughout its life cycle. The SLCMP instruction does not provide the guidelines and lessons learned on which the program manager can make the necessary tradeoffs and critical decisions required. The inprocess NAVAIR Software Management Manual will provide this guidance. NAVAIR should review the APL and MITRE reports and the Air Force documents and finalize its manual. With a concentrated effort, the instruction could be completed and signed within six months. The SCRB instruction appears almost ready for signature.

If NAVAIR completes the above documents, all of the policy set forth in DODD 5000.29 will effectively have been implemented with the exception of personnel training programs and software R&D efforts. These areas should be coordinated with NMC with the proposed solutions coming from the DOD or SECNAV level.

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